Circular No. 6081
August, 1928.

INFORMATION CIRCULAR

SEP 17 1928

DEPARTMENT OF COMMERCE - BUREAU OF MINES

RECOVERY OF FINE GOLD BY AMALGAMATION[1]

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This information circular is written in response to the many requests for information on the recovery, or reason for poor recovery, of fine gold by the amalgamation process.

Checking Gold Content

Experience has shown that in many cases error has been made because the true gold content of a particular sample or deposit was not known. Fire assays of representative samples give accurate results and should be considered final in determining the gold content.

Methods for obtaining representative samples are given in the usual textbooks dealing with mining and ore dressing. Copies are on file at all Universities and in most public libraries. See Richard's Ore Dressing, published by McGraw Hill Book Co., New York, and Taggart's Hand Book on Ore Dressing, John Wiley & Sons, New York. A list of competent assayers is published under professional classification in the Engineering and Mining Journal.

Nature of Gold

The best method for recovering gold depends on the form of its occurrence in the material to be handled. An experienced operator can obtain a good idea of the amount of free gold and can tell something as to the fineness of it by careful panning. The sulphides should be separated and cleaned from the free gold and gangue, and then weighed and assayed. If the sulphide carries gold, it is probable that part of the gold in the slimed portion is locked up with sulphides and will not amalgamate.

Of course it is advisable, if practicable, to have an expert make a microscopic examination and report on minerals present and how associated in the gangue. Such an examination is needed by the examining mining engineer or metallurgist before he can recommend methods of recovery.

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A description of the various forms of gold as found in nature is listed in textbooks on mineralogy, such as Dana's Textbook of Mineralogy, published by John Wiley & Sons, New York.

Float Gold

The fine gold lost in the usual amalgamation processes is often called "float gold." Most of this gold is probably in the form of thin laminae, flattened grains, or scales, and its loss is due to noncontact with the mercury. A thinner pulp, provided by the introduction of swinging amalgamated plates as obstructions in the pulp flow and the stirring action caused by more frequent drops onto the different sections of the amalgamation plates has improved the recovery of such gold. Fine gold is readily recoverable by good contact with the amalgamation plates and should not be confused with the gold included in fine sulphides or in other nonamalgamating forms.

More detailed information on float gold is given in Rose's Metallurgy of Gold, published by Griffin & Co., London, 1915, pages 205 and 206.

Rusty Gold

Rusty gold is a term that has been adopted to designate gold which, though apparently free, does not readily amalgamate. It is known that a thin film of sulphur, oxide of iron, silica, grease, or other substances may cover the surface of the gold particle and prevent amalgamation.

The film is usually attacked by grinding or some form of abrasion and by the use of alkalies or other chemicals to dissolve the grease.

The recovery of "rusty gold" is discussed in the Cyanide Handbook, by Clennell, published by McGraw Hill Book Co., New York, also in Rose's Metallurgy of Gold and in Peele's Mining Engineer's Handbook.

Pyrite

The fine gold which is contained in pyrite does not readily unite with mercury. This gold is mostly recovered with the pyrite concentrate or leached by cyanidation.

Tellurides do not give up the contained gold to direct amalgamation. The roasting of pyrite and tellurides improves the condition for amalgamating the gold but does not insure a high recovery. Rose's Metallurgy of Gold, pages 79 to 208, and Gowland's Metallurgy of Nonferrous Metals, page 206, each further discusses gold enclosed in pyrite, and give the usual metallurgical methods used in the recovery of gold from telluride.

Amalgamation

Silver-plated copper plates are generally used to recover the free gold from ore by amalgamation processes. For best results the plates must be kept as clean as possible. Mercury is worked into the surface of the plates until there is exposed a bright pasty amalgam that readily retains the gold as the ore pulp flows over the surface. To effect amalgamation each particle of gold must come

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into contact with the mercury; the attempt is made to accomplish this by passing the crushed ore and water in a thin layer over the entire surface of the plates and providing for a drop from each of the plates in the series.

A good article by A. W. Allen descriptive of the various methods of gold recovery by amalgamation appears in Engineering and Mining Journal, volume 116, 1923, pages 275-280. More details are given in Rose, Gowland, and Egleston's Metallurgy, and also in Peele's Handbook, or in Taggart's Ore Dressing. The following bulletins give the best California practice and can be obtained from the California State Mining Bureau, Ferry Building, San Francisco: Bulletin 46, California Gold Mine Practice, by E. B. Preston, 1895; Bulletin 85, Platinum and Allied Metals, by C. A. Logan, 1919.

Effect of Impurities

Good amalgamation conditions are easily reversed by the careless introduction of oils and grease. Soluble sulphides in the ore will darken the mercury and lower the gold recovery. Arsenic and antimony are particularly harmful. Many of the base metals unite with the mercury to form base bullion, or, even worse, cause the mercury to slough off and carry away precious metals.

Rose's Metallurgy of Gold and Clennell's Handbook on Cyanide give good advice on the effect of impurities.

Placer Gold

Placer gold refers to that gold obtained from alluvial deposits which may have been formed by stream, river, or by the action of water along beaches, and usually includes all gold-bearing loose sand or gravel.

The recovery of placer gold is usually made by drift mining on bed rock, hydraulic mining, or dredging. These methods are fully described in the following U. S. Bureau of Mines publications: Bulletin 127, dealing with gold dredging in United States; Bulletins 153 and 257, covering dredging in Alaska; Technical Papers 121 and 309, on placer mining; The California State Bureau of Mines Bulletin 57, by L. E. Auback, 1913, and Bulletin 92, Gold Placers of California, by Chas. Haley, 1923, discuss gold dredging in California.

Cyanidation

Since its introduction, the cyanide method of recovering fine gold from silicious ores has been the usual method employed for the recovery of gold lost in amalgamation processes. In many recently established plants, cyanidation has entirely supplanted amalgamation for the recovery of fine gold.

The theory and practice of cyanidation is well covered in the following publications: Cyaniding Gold and Silver Ores, by Julian and Smart; Manual of Cyanidation, by Hamilton; Chemistry of Cyanide Solutions, by Clennell; The

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Cyanide Handbook, by Clennell; U. S. Bureau of Mines Technical Paper 423, Cyanide Recovery of Gold and Silver Associated with Arsenic and Antimony in Ores. An extensive bibliography covering gold amalgamation and cyanide processes is given on page 1840 of the 1918 edition of Peele's Mining Engineer's Handbook.

Before expending any considerable time or money in attempting gold recovery, each prospect should be examined and approved by a competent operator familiar with the particular class of mining necessary, or by a competent mining engineer and metallurgist.

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